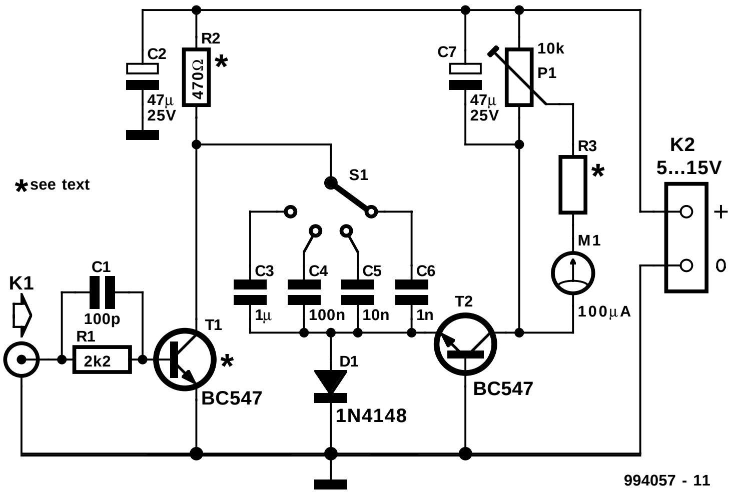
generator scale enhancement

013



F. Hueber

The set frequency of inexpensive frequency or function generators is often indicated by a simple scale on the tuning knob, which is not normally very accurate. It is possible to improve this by adding a counter discriminator circuit consisting of a small number of standard components as shown in the diagram.

The input should be a square wave at TTL level to drive transistor T_1 which functions as a switch. The *RC* network in the base circuit improves the switching operation at high frequencies.

One of capacitors C_3–C_6, depending on the position of switch S_1, is charged and discharged via T_1 and R_2 in synchrony with the input signal. Resistor R_2 plays an important role in achieving the wanted accuracy. If its value is high, the relevant capacitor cannot be charged fast enough at high frequencies, with the result that the signal at the collector of T_1 is no longer a true square wave. On the other hand, when T_1 is on, the current through the resistor, and thus the total current drain, is small. If, however, the value of R_2 is small, the relevant capacitor is charged at the correct speed, which improves the accuracy, but the current drain is higher. Clearly, the value of the resistor specified is a compromise between these requirements.

The charging and discharge currents of the relevant capacitor flow through the base-emitter junction of T_2 and diode D_1. Owing to the reactance of the capacitor, the currents vary linearly with the frequency. The relatively high currents would result in relatively high pulses at the collector of T_2 were it not for capacitor C_7 which integrates the pulses into a smooth direct voltage, whose level also depends on the frequency. The direct voltage is applied to a milliammeter, M_1, via preset P_1 and resistor R_3.

The circuit may be used for voltages in the range 5–15 V: the current drain, I_B, at several voltages, U_B, and the requisite value of R_3 for a 100 µA meter are shown in the table. The current level in brackets refers to R_2 having a value of 1 kΩ, but this results in the measurement error, which is normally about 2%, rising somewhat.

If current drain is of no consequence, the value of R_2 may be lowered until the current through T_1 just does not exceed the maximum permissible level of 100 mA. The minimum values of R_2 for various conditions are shown in the table.

The level of the supply voltage is not critical, but the voltage should be well regulated. If a digital display instead of an analogue meter is used, replace the meter by a 1 kΩ resistor and measure the voltage across this in the 200 mV range. When a liquid-crystal display (LCD) voltmeter is to be used, bear in mind that this needs a discrete supply. To use the total display range of an LCD voltmeter, the ranges may be set to 200 Hz, 2 kHz, 20 kHz, and 200 kHz. It is then necessary to use an r.f. transistor, such as the BSX20, in the T_1 position.

For good accuracy, capacitors C_3–C_6 must have the same tolerance and their values should be in a ratio of 1:10. Note that the circuit capacitance may have an effect when the switch is in the C_3 position.

To calibrate the circuit, apply in each range a square-wave input signal at a frequency of about 2/3 of the maximum in that range (660 Hz in the 1 kHz range) and adjust preset P_1 to obtain a voltage reading of about 2/3 of the maximum for that range. Without altering the setting of P_1, find the range in which the highest voltage reading is obtained. Adjust P_1 to exactly the input frequency. In the three other ranges, the readings are then slightly too small, but this is rectified by placing small value capacitors in parallel with the range capacitors until the correct frequency id displayed.

UB V	IB mA	R3 kΩ	R2 min Ω
5	9	15	56
9	15	39	100
12	19 (12)	56	120
15	22 (14)	68	150

If all this is too cumbersome, replace P_1 by a 10 kΩ resistor and solder four parallel-connected presets in series with R_3. These presets must be switched by a second wafer on S_1. This arrangement allows each range to be calibrated independently of the others. If, furthermore, a three-wafer switch is used, the third wafer enables the decimal point of an LCD to be switched in.

[994057]